Numerous springs flow from the Navajo Sandstone. Flux from these springs is limited to less than 10 gpm but is sufficient to provide water for a few cattle (Doelling et al. 2002). Other consolidated formations in the Spanish Valley, such as the Entrada Sandstone, are capable of transmitting and yielding small quantities of water but are not important as a water resource (Sumsion 1971).

Unconsolidated basin-fill deposits make up a secondary aquifer used mostly for irrigation and some domestic water supply in Spanish Valley (Steiger and Susong 1997). More than 200 wells completed in the unconsolidated material in the Moab-Spanish Valley area (Sumsion 1971) range in depth from 30 to 300 ft (Eisinger and Lowe 1999). Water in the unconsolidated aquifer is generally of poorer quality than that of the Glen Canyon and Entrada aquifers. Near the Colorado River, TDS and trace metals concentrations in the basin-fill aquifer increase as a result of dissolution of the underlying Paradox Formation salt beds (Cooper and Severn 1994).

3.1.7 Surface Water

3.1.7.1 Surface Water Resources

The Moab site is located within the Southeast Colorado Watershed Management Unit as designated by UDEQ's Division of Water Quality (UDEQ 2000). This watershed unit includes the Colorado River in the vicinity of the Moab site and all its tributaries and other water bodies between the Colorado River and the Colorado/Utah state line.

The principal surface water resource in the area, the Colorado River, lies 500 to 700 ft from the easternmost extent of the tailings pile, which is located on alluvial material deposited by the river. It flows south along the east edge of the site, and flows in deeply incised bedrock canyons cut by the river at the northeast and southwest borders of Moab Valley. The Colorado River flows south out of Moab Valley through The Portal, 1,000-ft sandstone cliffs flanking the entrance to the river canyon. The river drains one of the most arid sections of the North American continent. The rugged mountains, broad basins, and high plateaus in the Upper Colorado Basin (above Lees Ferry, Arizona) have been deeply entrenched and dissected (Price and Arnow 1974).

Courthouse Wash empties into the Colorado River 0.5 mile upstream from the tailings pile, and Moab Wash crosses the site along the north and east sides of the tailings pile. The channel of Moab Wash was rerouted east of the mill during operations to mitigate flooding potential during peak flows. Courthouse Wash drains 102 square miles, has an average discharge of 2.12 cfs, and produces peak flows reaching 12,300 cfs. Courthouse and Moab Washes are ephemeral and are dry much of the year. Courthouse Wash sustains flows for longer durations than Moab Wash, which drains an area of only 5 square miles (Smith Technology Corporation 1996). Moab Wash is an ungaged stream.

The Dolores River and the Green River empty into the Colorado River upstream and downstream, respectively, from Moab and the tailings pile. The Scott M. Matheson Wetlands Preserve (Matheson Wetlands Preserve), a shallow wetland open to the public and managed jointly by the Nature Conservancy and the Utah Division of Wildlife Resources (UDWR), is located across the river from the pile.

Natural streamflow of the Colorado River has been affected by many diversions and dams. The dams above the Moab area are not large in comparison to other dams in the Upper Colorado drainage system, such as the Flaming Gorge or Glen Canyon dams. The reservoirs along the Colorado River tributaries upstream of the Moab area store only about 10 percent of the total volume of water stored in Lake Powell (Van Steeter and Pitlick 1998), which is located 150 miles downstream from Moab. However, the presence of these dams has altered streamflow significantly by controlling the extreme high and low flows experienced prior to dam construction. These controlled flows have resulted in changes of river morphology and other characteristics such as sediment load (Van Steeter and Pitlick 1998).

The Cisco, Utah, gaging station (the closest station upstream of the site) is located 1 mile below the confluence of the Colorado and Dolores Rivers, and 31 miles upstream from the Moab site (NRC 1979). The drainage area above the gage is 24,100 square miles. The average discharge for 59 years of record (1911 to 1970) was 7,711 cfs, and maximum and minimum daily mean flows measured 73,200 cfs and 640 cfs, respectively. The complete period of record for the Cisco gaging station extends from January 1895 through 2003. The first 15 years consist of calendar-year rather than water-year discharge statistics. The maximum discharge for the complete period of record was 76,800 cfs.

3.1.7.2 Surface Water Quality

The Colorado River Basin Water Quality Control Project was established in 1960 (U.S. Department of Health, Education, and Welfare [HEW] 1961), and much of the early monitoring of the river was conducted in support of that project. A study conducted to determine the potential effects of the Moab site identified several constituents in the Colorado River in the study area that had concentrations above recommended limits, including sulfate, chloride, TDS, and manganese (HEW 1961). The presence of these constituents was attributed to natural causes. Highest levels of some analytes were detected in samples collected at the confluence of the Dolores River with the Colorado River. Studies of Colorado River water quality were undertaken in 1966 mainly to study the effects, if any, of uranium milling operations on the river. Radionuclides, particularly radium, were of main concern in these studies (HEW 1966).

In the 1970s, much of the focus on the Colorado River Basin concerned salinity control, pursuant to passage of the Colorado River Basin Salinity Control Act (Public Law 93-320). A major source of salinity load to the Colorado River, particularly in the Southeast Colorado Watershed Management Unit, is the Dolores River. As the Dolores River crosses the Paradox Valley in southwestern Colorado, highly saline ground water (brine) discharges to the river (Chafin 2003). The source of the brine is a collapsed salt anticline, similar to that in Moab Valley. Surface waters in the vicinity of the Moab site are influenced by discharge of ground water containing dissolved salts from the Paradox Formation that is found in the cores of salt anticlines characteristic of this region (DOE 2003). Highly saline ground water is known to occur beneath the Moab site as well as at the Matheson Wetlands Preserve across the river from the site. Near the confluence of the Dolores River and the Colorado River, the salinity of the Dolores River limits the use of river water for irrigation of some crops (UDEQ 2000). Onion Creek, another high-salinity tributary to the Colorado River, has been designated as an impaired water body because of elevated levels of TDS from both natural and agricultural sources (UDEQ 2000).

Several other water bodies in the Southeast Colorado Watershed Management Unit have been designated as impaired because of high TDS levels, including Mill Creek, which is a source of recharge to the alluvial aquifer across the Colorado River from the Moab site.

Selenium is also cause for regional concern. Although selenium levels have received greater attention in the Upper Colorado River Basin in Colorado, where concentrations have been detected up to 2 orders of magnitude above the National Ambient Water Quality Criteria of 0.005 mg/L (Spahr et al. 2000), concentrations in the vicinity of the Moab site are also relatively high. Concentrations of other constituents are known to be elevated in the Upper Colorado River Basin and the Southeast Colorado Watershed Management Unit as a result of the extractive industries; these effects tend to be more localized (Spahr et al. 2000; UDEQ 2000).

More recently, surface water monitoring of the Colorado River Basin, which includes the Moab site, has been conducted as required by the Clean Water Act. An intensive monitoring program took place between July 1997 and June 1998 to assess streams against state water quality standards and pollution indicators to determine if their designated beneficial uses were being met (UDEQ 2000).

Water quality of the Colorado River has declined over the years as human activities in the basin have expanded. Dams and water-diversion projects have greatly accelerated water loss through evaporation and consumption, resulting in higher salinities (i.e., higher TDS), altered temperature and flow regimes, and altered nutrient and suspended solids transport (NRC 1999). Industrial development (mining and milling in particular) and rapid urbanization have introduced wastewaters containing a variety of contaminants into the river, including suspended sediments, acid mine drainage, heavy metals, radionuclides, and organic wastes.

Despite the different factors that impair the surface water quality of the Colorado River, the portion of the river belonging to the Southeast Colorado Watershed Management Unit was assessed as fully supporting all its beneficial uses, according to results of the intensive monitoring conducted from July 1997 to June 1998. Therefore, the overall river water quality is considered to be good. Of the 981 stream miles within the Southeast Colorado Watershed Management Unit, 27 sampling sites were used in the assessment. Four of the 27 sampling sites were located on the Colorado River (UDEQ 2000).

3.1.7.3 Site-Related Surface Water Contamination

In addition to previous characterization, DOE conducted a baseline round of surface water sampling in the Colorado River near the site in summer 2002. Analytical results of samples collected adjacent to the site were compared to background concentrations and aquatic benchmarks to develop a list of contaminants of potential concern. The analytical results confirmed that ground water discharge from the Moab site has caused localized degradation of surface water quality. As a result of that evaluation, ammonia, copper, manganese, sulfate, and uranium are considered contaminants of concern.

Concentrations of contaminants of potential concern in surface water samples vary widely, depending on sampling locations and river flow conditions. Concentrations are most likely to be elevated during periods of average- to-low river stages in areas where water is shallow and slow moving or pooled. Concentrations are also highest immediately adjacent to the riverbank. The constituents with concentrations that are most consistently elevated in samples from the

Water from the Colorado River was not diverted for use in Moab-Spanish Valley prior to 1971, other than for the Atlas mill (Sumsion 1971). Domestic and public drinking water supplies are obtained from ground water, streams, and springs. In Utah, use of Colorado River water for purposes other than recreation is limited. In Grand County downstream from Moab, water is withdrawn from the river for irrigation of about 100 to 150 acres of hay and small grains, and a water right for consumptive use of 3 cfs is held for operations at Potash. No additional water withdrawals are believed to occur in Utah, including Canyonlands National Park and Lake Powell (NRC 1999). The Colorado River in the vicinity of Moab is used for swimming, rafting, boating, and fishing as well as other forms of recreation and is a recognized scenic waterway. The stretch of the river adjacent to the site is within the area designated as critical habitat for four endangered species of fish. For further details, see Section 3.1.10, "Aquatic Ecology."

3.1.7.5 Surface Water Quality Criteria

Five contaminants of concern in the surface water have been identified, as described in Section 3.1.7.3 (Site-Related Surface Water Contamination) and Appendix A2. There are no EPA surface water standards in 40 CFR 192. However, UMTRCA requires DOE to determine applicable regulations in consultation with the State of Utah. Surface water quality criteria for the protection of aquatic species have been developed in Appendix A2 for these contaminants of concern. The criteria for ammonia and copper are consistent with the standards currently specified in the Utah Administrative Code R317-2. In the case of ammonia, the State of Utah is in the process of updating its standards to be consistent with the current Ambient Water Quality Criteria published by EPA. Suter and Tsao (1996) were used where state and federal standards were not available. There are no federal or State of Utah standards for uranium or sulfate. Suter and Tsao developed estimated lowest chronic uranium values for fish extrapolated from laboratory studies. The lowest chronic value is considered conservative in comparison to results of studies on swim-up fry and juvenile Colorado pikeminnow (*Ptychocheilus lucius*), razorback sucker (*Xyrauchen texanus*), and bonytail (*Gila elegans*) (Hamilton 1995). Sulfate was retained as a contaminant of concern because concentrations are elevated when levels of other contaminants of concern are also elevated. Table 3–8 summarizes the protective criteria for each contaminant of concern.

3.1.8 Floodplains

The 100-year floodplains for Moab Wash and the Colorado River and the 500-year floodplain of the Colorado River occupy more than one-third of the Moab site (Figure 3–16). The Colorado River floodplains extend the length of the eastern site boundary from the river's edge to distances ranging from 500 to 1,200 ft west and are approximately 10 ft above the average river level. The tailings impoundment is located within the 100- and 500-year floodplains of the Colorado River and within the floodplain of the PMF. Two dams upstream of the Moab site affect the flow of the Colorado River: Blue Mesa Dam on the Gunnison River and McPhee Dam on the Dolores River.